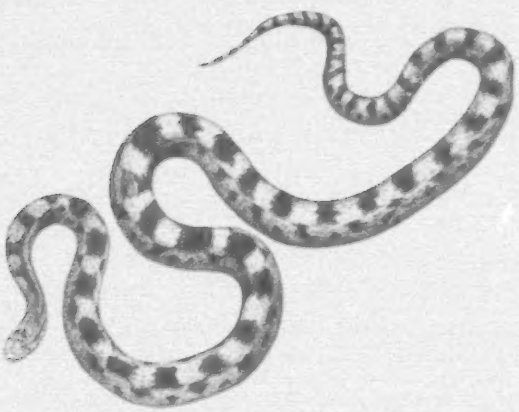
COSEWIC
Assessment and Status Report

on the

Gophersnake
Pituophis catenifer

Pacific Northwestern Gophersnake – *P.c. catenifer*
Great Basin Gophersnake – *P.C. deserticola*
Bullsnake – *P.C. sayi*

in Canada



EXTIRPATED - Pacific Northwestern Gophersnake – *P.c. catenifer*
THREATENED - Great Basin Gophersnake – *P.c. deserticola*
DATA DEFICIENT - Bullsnake – *P.c. sayi*
2002

COSEWIC
COMMITTEE ON THE STATUS OF
ENDANGERED WILDLIFE IN
CANADA

COSEPAC
COMITÉ SUR LA SITUATION DES
ESPÈCES EN PÉRIL
AU CANADA

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COSEWIC
Assessment Summary

Assessment Summary – May 2002

Common name
Pacific gophersnake

Scientific name
Pituophis catenifer catenifer

Status
Extirpated

Reason for designation
There have been no sightings of this subspecies in almost 50 years.

Occurrence
British Columbia

Status history
Designated Extirpated in May 2002. Assessment based on a new status report.

Assessment Summary – May 2002

Common name
Great Basin gophersnake

Scientific name
Pituophis catenifer deserticola

Status
Threatened

Reason for designation
There has been a significant loss of habitat as more agricultural land is converted from range land and shrub-steppe to orchards, vineyards and houses. There has been increased mortality through intentional and accidental killings in agricultural areas. Increasing numbers of roads and traffic also increase mortality rates.

Occurrence
British Columbia

Status history
Designated Threatened in May 2002. Assessment based on a new status report.

Assessment Summary – May 2002

Common name
Bullsnake

Scientific name
Pituophis catenifer sayi

Status
Data Deficient

Reason for designation
Grassland habitat used by this species has declined in extent because of cultivation and irrigation. The density of roads, paved roads and traffic has increased steadily and increased the mortality rate of snakes. Bullsnakes are particularly vulnerable to persecution at hibernacula and to persecution in general because they are large and resemble rattlesnakes. However, there is little direct evidence that this subspecies is declining in either range or abundance in Canada. There is a recommendation to reassess the bullsnake within five years when new information should be available from the relevant jurisdictions.

Occurrence
Alberta, Saskatchewan

Status history
Placed in the Data Deficient category in May 2002. Assessment based on a new status report.

COSEWIC
Executive Summary

Gophersnake
Pituophis catenifer

Species information

The Gophersnake (*Pituophis catenifer*) is a large (up to 2000 mm total length), yellow or cream snake, with dark spots and a dark line across the face, from the eye to the jaw. Three subspecies are recognized in Canada, the Bullsnake (*P.c. sayi*), the Great Basin Gophersnake (*P.c. deserticola*), and the Pacific Gophersnake (*P.c. catenifer*).

Distribution

Pituophis catenifer is found in southern British Columbia, Alberta, and Saskatchewan, and farther south through the United States to Mexico.

Habitat

These snakes are found in dry, grassland or forested areas with rocky cliffs or talus slopes suitable for den sites.

Biology

Males and females mate in the spring after emergence from the hibernacula, and spend the active season in suitable foraging habitat, feeding primarily on mammals. Eggs are laid in early July, in abandoned rodent burrows or talus slopes, and the hatchlings emerge from the nest sites in late September. Individual snakes are capable of moving long distances between den sites, nesting sites, and summer foraging areas.

Population sizes and trends

No comprehensive study has been done on the distribution of Gophersnakes and Bullsnakes in Canada, and trends, though described in general terms, are not certain. The Pacific Gophersnake, *P.c. catenifer*, was once found on Galiano Island and likely occurred in the extreme southwest mainland, but it is now believed to be extirpated from Canada. *P.c. deserticola*, the Great Basin Gophersnake, occurs at low to moderate densities in southern British Columbia with much of its habitat threatened by agricultural and urban development. *P.c. sayi*, the Bullsnake, is widespread in Alberta and

Saskatchewan, but common in very few locations. Both *P.c. deserticola* and *P.c. sayi* may be declining in number of populations and in population size, even in protected areas.

Limiting factors and threats

The most important factor in the decline of this species is degradation or loss of habitat. Suitable habitat for *P.c. deserticola* in B.C. occurs in a small area in the province, and urbanization and cultivation are rapidly destroying the remaining habitat. Bullsnakes are subject to destruction of den sites and fragmentation of grassland habitat in Alberta and Saskatchewan. Humans are also a direct threat to snakes, either by driving over snakes that may be lying on or crossing roads, or by deliberately killing the snakes because of their superficial resemblance to rattlesnakes, their large size, and a general dislike of all snakes.

This species is at the northern limit of its range in Canada, and has a limited distribution in this country. The active season is apparently not long enough for females to reproduce every year. They seem to mature at a smaller size than populations farther south, and possibly at a later age, but it is not known if these differences are phenotypic or genotypic. If Gophersnakes and Bullsnakes take longer to mature in Canada than in more southerly populations, then the populations would be slower to recover from declines than ones further south.

Special significance of the species

The Gophersnake is economically important because it preys on small mammals, some of which are major crop pests. It is known that these snakes can remove a large proportion of the small mammals in an area.

Existing protection or other status designations

Pituophis c. catenifer is on the British Columbia red list, and is considered to be extirpated by the Conservation Data Centre, while *P.c. deserticola* is on the provincial blue list. Bullsnakes are on the Alberta yellow list, and are not tracked by the CDC in Saskatchewan.

Editor's Note: We have updated the authors' original taxonomy by changing the species name from *Pituophis melanoleucus* to *P. catenifer* [Reichling (1995); Rodriguez-Robles (1998b); Crother et al. (2000)]. Currently, there are two species (*P. melanoleucus* = pinesnake and *P. catenifer* = Gophersnakes and Bullsnakes). The subspecies *P.c. sayi* could eventually be placed in the *P. melanoleucus* species group or changed to species status (Crother et al. 2000).

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) determines the national status of wild species, subspecies, varieties, and nationally significant populations that are considered to be at risk in Canada. Designations are made on all native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fish, lepidopterans, molluscs, vascular plants, lichens, and mosses.

COSEWIC MEMBERSHIP

COSEWIC comprises representatives from each provincial and territorial government wildlife agency, four federal agencies (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biosystematic Partnership), three nonjurisdictional members and the co-chairs of the species specialist groups. The committee meets to consider status reports on candidate species.

DEFINITIONS

Species	Any indigenous species, subspecies, variety, or geographically defined population of wild fauna and flora.
Extinct (X)	A species that no longer exists.
Extirpated (XT)	A species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A species facing imminent extirpation or extinction.
Threatened (T)	A species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
Not at Risk (NAR)**	A species that has been evaluated and found to be not at risk.
Data Deficient (DD)***	A species for which there is insufficient scientific information to support status designation.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.
** Formerly described as "Not In Any Category", or "No Designation Required."
*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994.

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list.

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COSEWIC Status Report

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Bullsnake – *P.c. sayi*

in Canada

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2002

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SPECIES INFORMATION

Name and classification

Pituophis belongs to the tribe Lampropeltini (F: Colubridae), which also includes *Arizona*, *Cemophora*, *Lampropeltis*, *Rhinocheilus*, and *Stilosoma* (Keogh 1996). *Pituophis melanoleucus catenifer* and *P.m. deserticola* are now referred to *as P. catenifer catenifer* and *P.c. deserticola* by most authors, such as Conant and Collins 1991; Reichling 1995; Rodriguez-Robles 1998b; Gregory and Gregory 1999; Crother et al. 2000. This is a partial return to the taxonomy accepted before 1951, when Smith and Kennedy (1951) combined all Gophersnakes, Pinesnakes, and Bullsnakes into one species (Table 1). As yet unpublished phylogenetic analyses of mitochondrial DNA sequences suggest that *Pituophis* should best be divided into at least two species, *P. catenifer* in the western and central United States, and *P. melanoleucus* in the east (Rodríguez-Robles 1998b). *Pituophis c. sayi* has morphological characters intermediate to the Pinesnakes (*P. melanoleucus*) and the Gophersnakes (*P. catenifer*) (Reichling 1995), and most authors refer to this subspecies as belonging to *melanoleucus*, but molecular analyses could place this subspecies in the species *catenifer* as well (J.A. Rodriguez-Robles, pers. comm.). Differences in snout morphology can also be used to separate the "eastern" group of subspecies (including *sayi*) and the "western" group (including *deserticola*) (Knight 1986).

Editor's Note: We have updated the authors' original taxonomy by changing the species name from *Pituophis melanoleucus* to *P. catenifer* [Reichling (1995); Rodriguez-Robles (1998b); Gregory and Gregory 1999; Crother et al. (2000)]. Currently, there are two species (*P. melanoleucus* = pinesnake and *P. catenifer* = Northwestern Gartersnakes and Bullsnakes). The subspecies *P.c. sayi* could eventually be placed in the *P. melanoleucus* species group, as suggested above, or could remain as a subspecies of *P. catenifer*, or be elevated to species status (Crother et al. 2000).

Description

Pituophis catenifer is a large snake with a moderately long tail; adults can reach a total length of 1800 mm in the northwest, and 2750 mm in southern parts of the range (Nussbaum et al. 1983). The head is a little larger than the neck, with a narrow snout that projects past the lower jaw, and the eye is large with a round pupil (Gregory and Campbell 1984). The ground colour is yellowish or cream with black, brown, or red-brown dorsal blotches, which are usually more widely spaced on the tail than on the body (Stebbins 1985). There are several series of smaller blotches along the sides of the body. A dark line crosses the head in front of the eyes, with a dark band from the eye to the angle of the jaw and a dark vertical spot below the eye. The ventral surface is yellow or yellow-white with brown or black spots (Gregory and Campbell 1984). The dorsal scales are keeled, with 27-37 rows midbody (Stebbins 1985). Scales on the side of the snake are smooth, and the keels on the dorsal scales are dark brown (Gregory and Campbell 1984). There are usually 7-10 upper labials and 12 or 13 lower labials (Nussbaum et al. 1983), 4 prefrontals, and a single anal scale (Stebbins 1985). Males have longer tails than females (Nussbaum et al. 1983; Shewchuk 1997), and the young look similar to the adults (Storm and Leonard 1995).

Table 1. Synonyms for *Pituophis catenifer catenifer*, *P.c. deserticola*, and *P.c. sayi*, as given by Sweet and Parker (1990).

Catenifer	*Deserticola*	*Sayi*
Coluber catenifer Blainville (1835)	*Pituophis bellona* Cooper (1870)	*Coluber melanoleucus* var. *Say* Harlan (1827)
Pituophis catenifer Baird and Girard (1853)	*Pituophis bellona* Cope (1872)	*Coluber sayi* Shlegel (1837)
Pituophis wilkesii Baird and Girard (1853)	*Pituophis sayi* var. *bellona* Cope (1875)	*Churchillia bellona* Baird and Girard (1853)
Pituophis catenifer Baird (1859)	*Pituophis sayi sayi* Yarrow (1883)	*Pituophis bellona* Baird and Girard (1853; part)
Pituophis vertebralis Hallowell (1859)	*Pituophis catenifer* Cope (1883)	*Pituophis McClellani* Baird and Girard (1853)
Pituophis melanoleucus var. *catenifer* Jan (1863)	*Pituophis catenifer bellona* Garman (1884)	*Pituophis bellona* Kennicott and Baird (1859)
Pituophis wilhesii Lord (1866).	*Pituophis catenifer* Stejneger (1891)	*Pituophis mcclellani* Baird (1859)
Pituophis wilksei Wright (1878)	*Pituophis catenifer deserticola* Stejneger (1893)	*Pituophis sayi* Cooper (1860)
Pituophis sayi bellona Yarrow and Henshaw (1878)	*Pituophis catenifer sayi* Ruthven (1915)	*Pituophis melanoleucus* Wied-Neuwied (1865; part)
Pituophis mexicanus bellona Cope (1883)	*Pituophis catenifer stejnegeri* Van Denburgh (1920)	*Pituophis sayi sayi* Cope (1875)
Pituophis sayi sayi Yarrow (1883)	*Pituophis melanoleucus deserticola* Smith and Kennedy (1951)	*Pituophis catenifer* var. *sayi* Garman (1884)
Pituophis catenifer catenifer Brown (1901)	*Pituophis catenifer deserticola* Crother et al. (2000)	*Pituophis sayi* var. *bellona* White (1884)
Pituophis catenifer catenifer Dice (1916)		*Pituophis sayii* Higley (1889)
Pituophis catenifer heermanni Van Denburgh (1920)		*Pituophis catenifer sayi* Taylor (1891)
Pituophis catenifer annectens Stull (1932)		*Pituophis catenifer bellona* Taylor (1891)
Pituophis melanoleucus catenifer Smith and Kennedy (1951)		*Coluber melanoleucus* Boulenger (1894)
Pituophis catenifer catenifer Crother et al. (2000)		*Pituophis macclellani* Cope (1900)
		Pituophis melanoleuca Lewis (1905)
		Pituophis catenifer sayi Notestein (1905)
		Pituophis catenifer sayi Gaige (1914)
		Pituophis sayi sayi Force (1925)
		Pituophis melanoleucus sayi Smith and Kennedy (1951)
		Pituophis catenifer sayi Crother et al. (2000)

Pituophis c. sayi, the Bullsnake, has a narrow rostral scale raised above the nearby scales (Stebbins 1985), and can reach 2000 mm long (Russell and Bauer 1993). This snake has 36-66 blotches on the body and 9-19 on the tail (Wright and Wright 1957). *Pituophis c. deserticola*, the Great Basin Gophersnake, has 29-37 (usually 31 or 33) scale rows, 46-66 dorsal blotches, and 12-21 tail blotches. Males have 224-252 ventral scales and 58-72 caudal scales, whereas females have 223-263 ventral scales and 50-67 caudal scales (Nussbaum et al. 1983). The black dorsal blotches toward the front of the body are connected to each other and to secondary blotches on the side of the neck to form a lateral dark band (Stebbins 1985). *Pituophis c. catenifer*, the Pacific Gophersnake, has 29-33 (usually 31) dorsal scale rows, 56-93 dorsal blotches, and 14-30 tail blotches. Males have 207-230 ventral scales and 59-79 caudal scales, and females have 200-230 ventral scales and 53-78 caudal scales (Nussbaum et al. 1983). The spots on the side of the body and under the tail are grey, and the dorsal blotches toward the front of the body are separated from each other and from the secondary blotches (Stebbins 1985).

Until recently, very little work had been done on *P. catenifer* in Canada. Many records of den sites and number of snakes at dens were incidentally reported from rattlesnake research and historical accounts of rattlesnake hunts. Recent work on the Gophersnake in British Columbia includes the research of Shewchuk (1997) on reproduction and movement in the Okanagan Valley, and den and habitat surveys by Sarell (1993), Bertram et al. (2001), Hobbs (2001) and Hobbs and Sarell (2002) in the Thompson/Fraser, Okanagan, Williams Lake and 100-Mile regions. Studies in Alberta include den surveys by A. Didiuk at Suffield National Wildlife Area (Didiuk 1999a,b; A. Didiuk, unpublished data), and also research by Alberta Environmental Protection (1996, 1998) and Cottonwood Consultants (1986, 1987). All other population studies on Gophersnakes and Bullsnakes have been performed on populations and individuals in the United States, unless indicated otherwise.

DISTRIBUTION

Species' range

Pituophis ranges from the Pacific to the Atlantic Coast, and from southwestern Canada to the tip of Baja California, up to 2740 m elevation (Stebbins 1985). The range of this species may be limited in the north in part by summer temperatures, particularly the range of temperatures available for optimal incubation of eggs (Burger 1991), and/or by winter temperatures and the availability of suitable den sites (Shewchuk 1997).

Subspecies' range

Pituophis c. catenifer is found in western Oregon (Nussbaum et al. 1983) and California (Wright and Wright 1957), to 610 m elevation in Oregon (Storm and Leonard 1995) (Fig. 1). It has been collected from two locations in British Columbia; Galiano Island and near the border at Sumas, Washington (Wright and Wright 1957), and was probably a relict in British Columbia (Gregory and Campbell 1984) (Fig. 2).

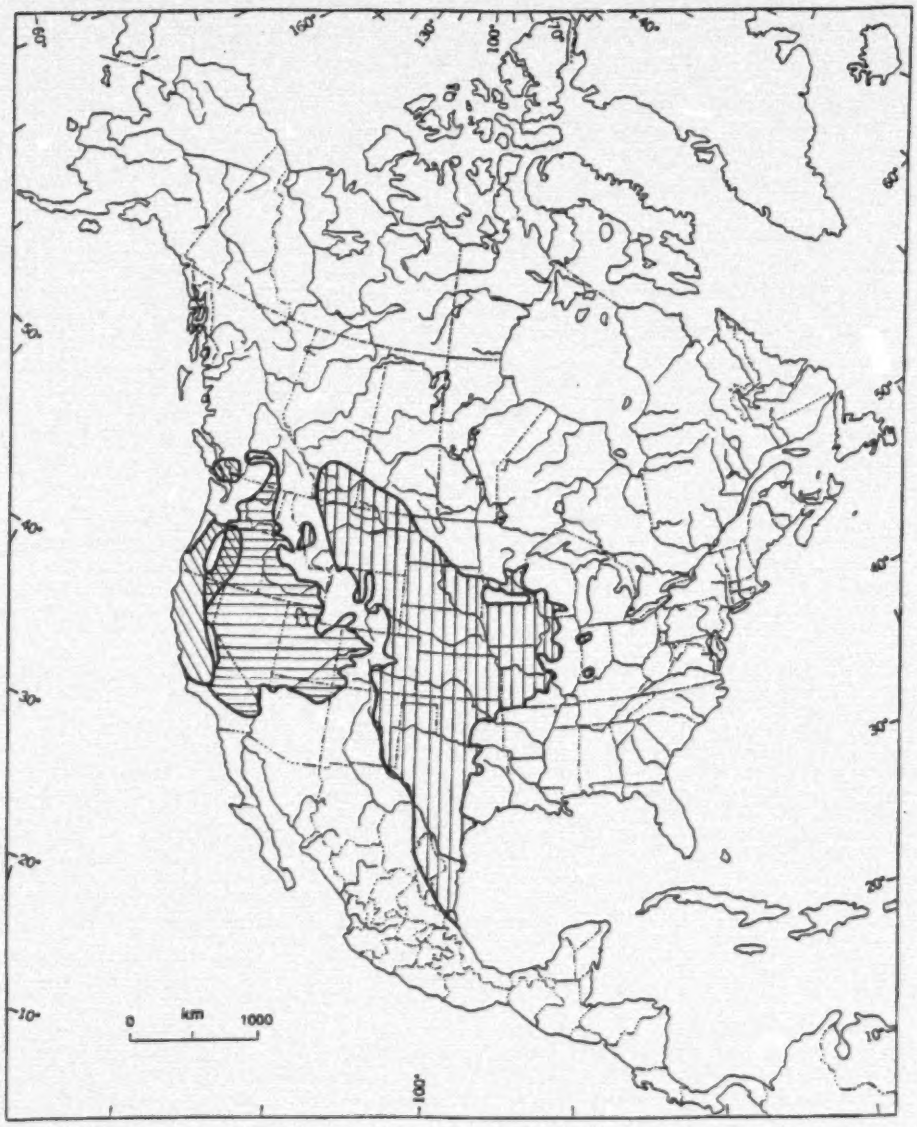

Figure1. North American distribution of *Pituophis melanoleucus catenifer* (\\\\\\\), *P.c. deserticola* (=====), and *P.c. sayi* (|||||||||). Ranges from Storm and Leonard (1995), Conant and Collins (1991), and Stebbins (1985).

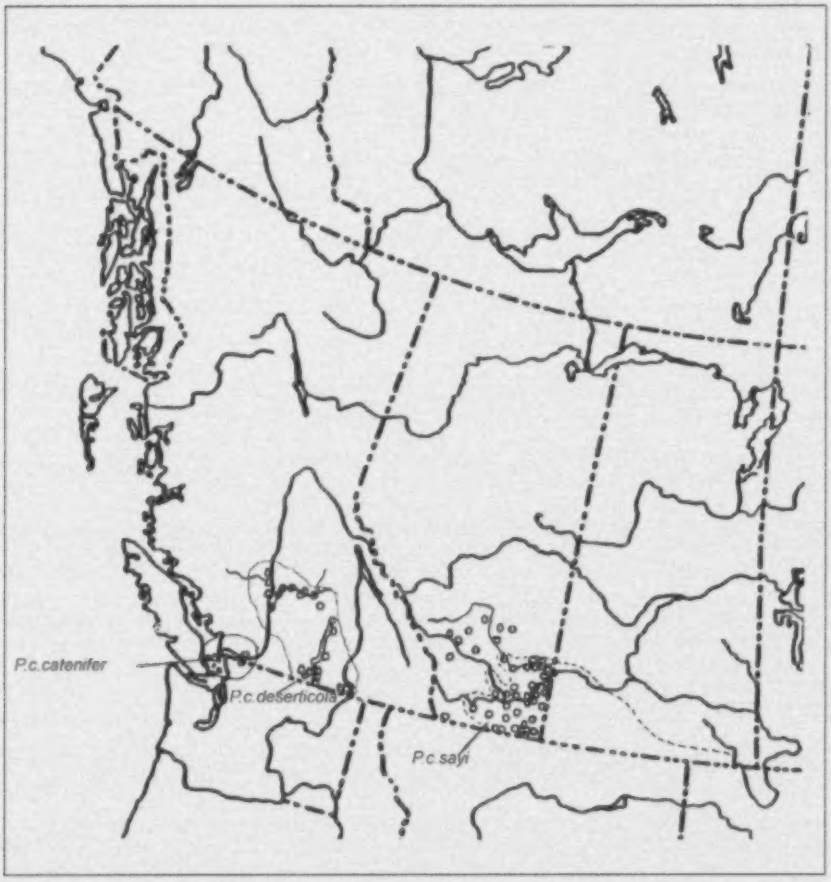

Figure 2. Canadian distribution of *Pituophis melanoleucus catenifer*, *P.c. deserticola*, and *P.c. sayi*. Locations from B.C. CDC (1998), Nussbaum et al. (1983), Gregory and Campbell (1984), Russell and Bauer (1993), Alberta Biodiversity Observation Database (1998), Cook (1984), and Cottonwood Consultants (1986).

Pituophis c. deserticola occurs in five discrete populations in the interior "Dry Belt" in B.C. (the valleys of the Thompson, Okanagan and parts of the Fraser and Similkameen rivers), although the four southern populations (Trail, Grand Forks, Midway and Okanagan) are connected south of the Canadian border (Hobbs and Sarell 2001; Fig.3). The 5 B.C. populations are thought to have been one contiguous population during the Hypsothermic period 8,000 years ago; however, the most northerly population (Thompson/ Fraser) has since become completely isolated. In the United States it is found in central and eastern Washington, eastern Oregon, central and southern Idaho, eastern California, Nevada, Utah, southwest Wyoming, western Colorado, northwest New Mexico, and northern Arizona (Wright and Wright, 1957). It occurs in eastern Washington to 797 m and eastern Oregon to 1676 m (Storm and Leonard 1995), but most records are below 700 m (Wright and Wright, 1957).

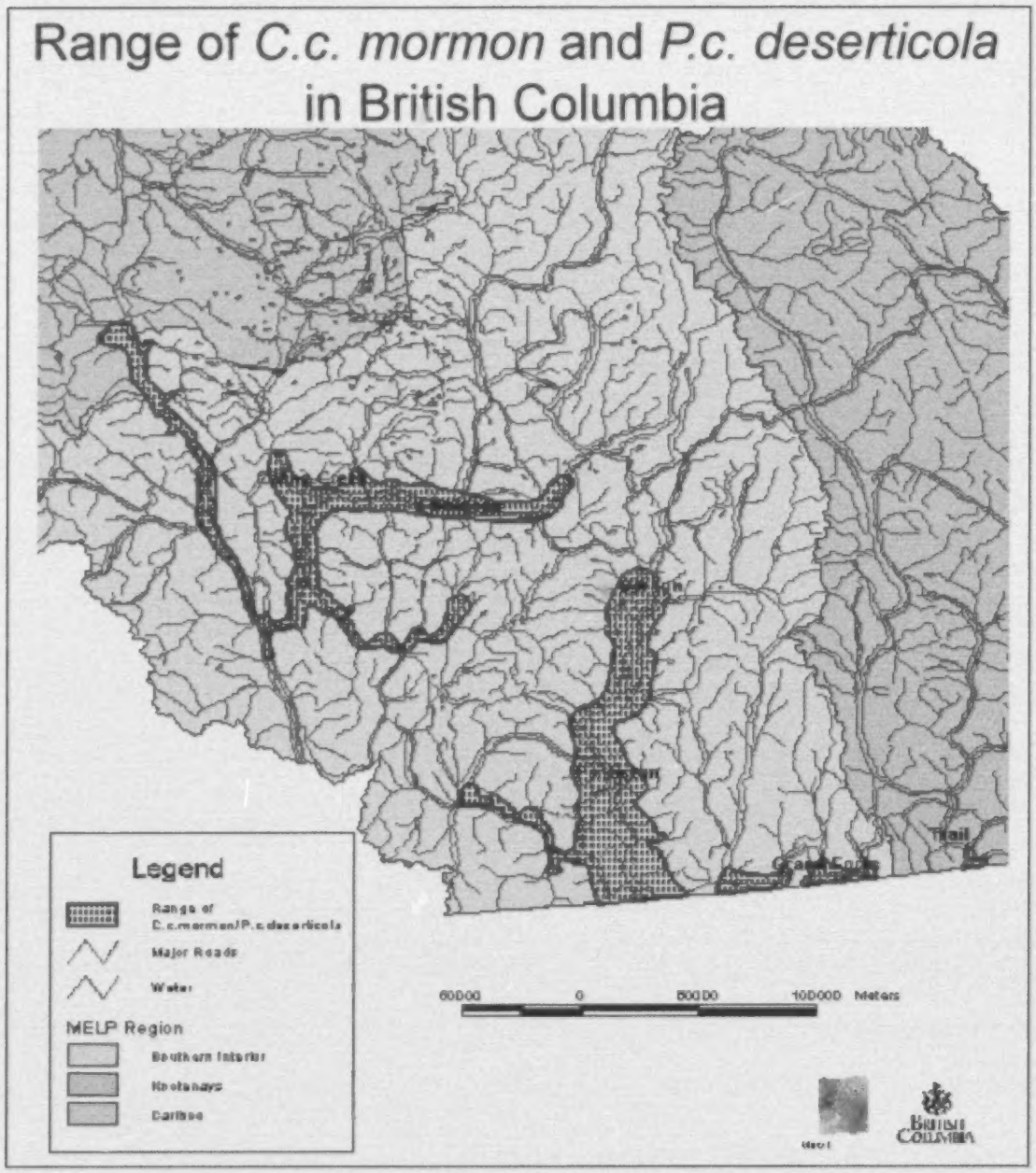

Figure 3. British Columbia distribution of *Pituophis catenifer deserticola* and *Coluber constrictor mormon*.

In Alberta, the distribution of *P.c. sayi* extends from the Montana border to Trochu, and west from the Saskatchewan border to Calgary, up to 2000 m in elevation (Russell and Bauer 1993; Figure 2). It mostly occurs in the Mixed Grassland region, in the Milk, South Saskatchewan, and lower Red Deer River valleys (Cottonwood Consultants 1986). It has been found in Saskatchewan east of the Alberta border to Big Muddy Valley (A. Didiuk, pers.comm.), and north to the South Saskatchewan River (Froom 1972; Figure 2). The Bullsnake also occurs south of Canada to northeastern Mexico and west from eastern Idaho to western Indiana (Wright and Wright 1957). In general, *P. catenifer* seems to be declining in range with several isolated (relict) populations on eastern and northwestern limits of its range (Fig. 1).

HABITAT

General habitat

This species occupies a variety of habitats, from lowlands to mountains, and from coast to coast. It is usually found in desert, prairie, brushland, woodland, open coniferous forest, and farmland, and is especially common in grassland and open brushland in the west (Stebbins 1985). In the northwest, Gophersnakes are generally not found in dense forest and high mountains, but are most common in semi-arid brushy areas (Nussbaum et al. 1983). *Pituophis c. catenifer* in British Columbia was found in grassland habitat, and *P.c. deserticola* is restricted to grasslands, shrub steppe, and dry open forest of the ponderosa pine - bunchgrass biogeoclimatic zone of a few (5) south Interior valleys (British Columbia Conservation Data Centre 1998; Cannings et al. 1999). The Okanagan Valley has hot, dry summers, and comparatively mild winters with little snow. The Gophersnakes at one location in the Okanagan occupied an area that had a band of cliff/talus slope separated from a riparian zone by a dry, sandy beach. There were shrubs at the base of the talus slope, and ponderosa pine and douglas fir farther upslope. The sandy terrace had antelope brush, cheat grass, knapweed, and prickly-pear cactus, while the floodplain was covered with meadow and wetland plant species (Shewchuk 1997). In Alberta, the Bullsnake is limited to short-grass prairie, and is found mostly in drier grassland or sagebrush habitat, and in farmlands and fields. It usually occupies areas with sandy soil, in association with rock piles or boulders (Russell and Bauer 1993). It is often seen near extensive badlands, where there are suitable hibernacula (Cottonwood Consultants 1986) and is usually associated with river valleys and the tunnel systems of the northern pocket gopher (A. Didiuk, pers.comm.). Bullsnakes are found in mixed grassland, cypress upland, and moist mixed grassland habitats in Saskatchewan (CDC 1998).

At Shewchuk's study area in the Okanagan, only three den sites were found. Two were in a rocky bluff, about 200m apart, one was closely associated with a talus slope and the other simply a crack in the rock at the base of a cliff. The third was about 1000 m away in similar rocky habitat. These dens were located above the valley bottom (Shewchuk 1997), which may protect the snakes from thermal inversion (Rosen 1991). Other snake species found at the den site with the talus slope were *Crotalus viridis*

oreganus (Northern Pacific Rattlesnake), *Coluber constrictor mormon* (Western Yellow-bellied Racer), and *Thamnophis sirtalis fitchi* (Valley Gartersnake) (Shewchuk 1997). Three P.c. deserticola den sites were also found in the Thompson-Nicola region of British Columbia in 2000 (Bertram et al. 2001). These sites were shared by the Western Yellow-bellied Racer and the Wandering Gartersnake (*Thamnophis elegans*).

Den (= hibernacula) sites in the Thompson region of British Columbia are mainly in the bunchgrass (BG) zone, but some are in the hot, dry ponderosa pine grassland zone (Bertram et al. 2001). Each of the three sites found by Bertram et al. (2001) were considerably different from one another. The first was located in the gravel bed of a railway track in an open and flat area, the second on the side a small dry gully in a complex of rodent holes, and the third was on a very steep (130%) northeast facing slope of a 100m deep creek gully. In the northern Okanagan valley, dens are usually in the hot, dry timber and grassland variants of the Interior Douglas-fir zone, while in the Central Okanagan, dens are restricted to a small part of the east side of the valley. Most known snake dens are in the southern Okanagan, and Gophersnakes were found at nine of these dens (Sarell 1993), while 5 of 24 dens located in the North Okanagan contained Gophersnakes (Macartney 1985). Most of the dens were between 400 and 780 m above sea level, and were on a slope (Sarell 1993).

In Alberta, den sites are mainly located in the Mixed Grassland ecoregion, and are also used by *Crotalus viridis viridis* (Prairie Rattlesnake), *Thamnophis radix* (Plains Gartersnake), *T. elegans vagrans* (Wandering Gartersnake), and occasionally *Heterodon nasicus nasicus* (Plains Hog-nosed Snake) and *T. sirtalis parietalis* (Red-sided Gartersnake) (Hofman 1991). A survey in 1986 located about 20 Bullsnake dens in Alberta, from the Rocky Mountains to the Saskatchewan border, and from the Red Deer River to the United States border. Most of the bull snake dens were in major valleys with eroded slopes, in south- or west-facing fissures in bedrock or in holes in "slump blocks", so were confined to limited areas along the main rivers. All of the Bullsnake dens were also used by prairie rattlesnakes and sometimes by gartersnakes (Cottonwood Consultants 1987). One den in Saskatchewan consisted of badger holes part way down a southeast-facing slope in the badlands, and was occupied by Bullsnakes and Prairie Rattlesnakes. This den had apparently been used since the early 1900s (Cottonwood Consultants 1987). In other parts of the species' range, den sites have been described as consisting of aggregations of rounded rocks (Parker and Brown 1973), talus aggregations, and volcanic rock containing a series of cracks (Parker 1974).

Foraging in the Thompson region of B.C. occurs mainly in wetter areas of the bunchgrass and hot dry ponderosa pine zones and nearby grassland habitat (D. Low, pers. comm.). Gophersnakes in the south Okanagan foraged in dry sandy and riparian habitats, and often used the edge between the sand and riparian habitats. The snakes may use rodent holes in sandy habitats as retreats to take advantage of the lag in the heating of the substrate to optimize body temperatures over a longer period of the day (Shewchuk 1997). Bullsnakes in Alberta forage in the grasslands adjacent to den sites (Cottonwood Consultants 1987).

The nests of *P.c. deserticola* in Utah are usually in abandoned mammal burrows on south-facing slopes with no perennial vegetation, and are frequently communal with other Gophersnakes and other snake species. Females may use the same nest site year after year (Nussbaum et al. 1983). In British Columbia, one female was observed using a rodent burrow as a nest, excavating excess soil and the eggs of a Yellow-bellied Racer (*Coluber constrictor*) before laying her own eggs. After protective fencing was placed around the nest, it was observed that 46 *C. constrictor* and 13 *P.c. deserticola* hatchlings were produced, the output of possibly two Gophersnakes and 5 to 9 racers. This site was used by both species for nesting the following year (Shewchuk 1997). Communal nesting is probably an indication that suitable nest sites are limited (Porchuk and Brooks 1995), and chosen for their thermal (Shewchuk 1997) and hydric characteristics (Packard and Packard 1986). Nests in burrows range in size from 9-10 cm high and 12-17 cm wide, with the eggs 34-43 cm down from the entrance (Parker and Brown 1980). Gophersnakes may also lay their eggs in talus slopes (Brodie et al. 1969; Shewchuk 1997), or under logs and stumps farther south in their range (Johnson 1987). Egg-laying sites in the Thompson region are generally in the bunchgrass or hot, dry ponderosa pine and its grassland variant zones (D. Low, pers. comm.).

Trends

In Saskatchewan, about half of the Mixed Grassland habitat type is cultivated, and the rest is used for grazing (BC - CDC 1998). If *P.c. catenifer* still occurs in British Columbia, its habitat is rapidly declining, due to urbanization in the lower Fraser Valley and Gulf Islands, and loss of native grasslands. The habitat occupied by *P.c. deserticola* in British Columbia makes up less than 10% of the total area of British Columbia (M. Sarell, pers.comm.), and is also declining rapidly in quality and size (BC - CDC 1998). The habitats used for den and nest sites in the Thompson region are very restricted and are now in danger of being shaded out by encroaching forests due to lack of frequent fires (D. Low, pers. comm.). Urban development is reducing the amount of habitat available in the Kamloops area (D. Low, pers. comm.).

Some of the dens mentioned in the 1986 survey by Cottonwood Consultants (1987) in Alberta had not been visited for several years at least, and have not been surveyed since, whereas others were known to have existed for decades.

Protection/ownership

There are no known occurrences of *P.c. catenifer* in protected areas in British Columbia (BC - CDC 1998). At least two locations of *P.c. deserticola* in B.C. are on an ecological reserve, and there have been sightings of Gophersnakes in various parks. There are 7 ecological reserves in the ponderosa pine-bunchgrass zones, covering a total of 515.2 ha (B.C. Parks 1994); there are very few parks of any size in the Thompson-Okanagan region, but Kamalka Lake and Okanagan Mountain Parks are both large and have Gophersnakes (P. Gregory, pers.comm.). Less than 1% of the Southern Interior and Central Interior ecoregions of British Columbia are protected, and less than 1% of all grasslands in that province are protected (Pitt and Hooper 1994).

Even though Gophersnakes on ecological reserves are protected, many are killed on roads on or nearby the reserves. Thirteen percent of the total number of snakes found in one location were collected as road kills. On the same site, cattle and horses were allowed to graze, modifying the vegetative cover, compacting the soil, and trampling snakes (Shewchuk 1997). Most snake dens in the south Okanagan are on private lands (28% of those found in 1993), and the rest are in Provincial Forests (22%), Indian Reserves (20%), land owned by public and private conservation organizations (17%), and Crown land (2%) (Sarell 1993). It is unclear how many of the dens in each of these categories contained Gophersnakes.

Many of the sightings in Alberta are within provincial parks, especially in the centre of the range of the subspecies, but most of the sightings in the peripheral parts of the range are not in protected habitat. In the 1986 survey by Cottonwood Consultants (1987), 13 of the dens (current and historical) were on Public Lands Crown Grazing Leases, 5 were on Special Areas Crown Grazing Leases, 2 were on private land, and one was on the CFB Suffield Military Reserve. Most of the landowners with snake dens on their land were willing to protect the dens (Cottonwood Consultants 1987); presumably those who were not did not respond to the survey and/or had already eliminated the den on their land. Dinosaur Provincial Park, Saskatchewan, had, and may still have, a sizeable population of Bullsnakes. It is unclear whether or not any other provincial and historic parks within the range of the Bullsnake in Saskatchewan have substantial populations.

Current protection is likely not adequate, as most of the Crown land is actually leased out for grazing and suffers some degree of alteration and fragmentation by roads. Protection of hibernacula on Crown land should be possible through the provincial governments, and perhaps covenants to protect dens on private land, coupled with some sort of compensation or recognition, would ensure the persistence of those dens.

BIOLOGY

Reproduction

Males emerge before the females, and occasionally perform "combat" during the mating season (Shaw 1951; Nussbaum et al. 1983). *Pituophis c. sayi* males will follow females in the spring, apparently attracted by skin secretions (Smith and Iverson 1993). The male (*P.c. deserticola*) lies along and on top of the female, and often bites the female on the back and behind the head (Gregory and Campbell 1984). In Idaho, females ovulated June 1-20 and deposited eggs June 27-July 19. The eggs hatched October 7-27 with an average length of incubation of 125 days (Diller and Wallace 1996). In British Columbia, mating has been observed throughout May, with ovulation in June and oviposition by mid-July. Eggs from one clutch in British Columbia hatched in September, 74 to 76 days after deposition (Shewchuk 1997). The timing of laying, ovulation, and hatching appears to be similar to that farther south in Utah (Parker and Brown 1980; Shewchuk 1997).

Most (97%) of the females in a study in Idaho were annually reproductive (Diller and Wallace 1996), but 37.5% of adult-sized females in British Columbia were not gravid (Shewchuk 1997), and only 33% of adult females in Nebraska were gravid (Gutzke et al. 1985). This suggests biennial or at least less than annual reproduction, which would limit a population's potential for growth or for recovery from a decline, although at this low level of reproduction a population could probably remain stable for a year or two with no recruitment, especially given high survivorship of adults.

The eggs in the nest are often laid touching each other, and have smooth shells. In Oregon, *P.c. catenifer* lay 3-9 eggs (Nussbaum et al. 1983), in Utah 4-15 (Parker and Brown 1980), in Idaho 6.9 + 2.1 (Diller and Wallace 1996) and in British Columbia 4.6 eggs (range 2-8). In Idaho, the eggs are generally 27-31 mm wide and 47-74 mm long (Diller and Wallace 1996). They are 16.7-30 mm wide and 40-70.5 mm long in British Columbia (Shewchuk 1997). Clutch size was significantly correlated with female SVL, and the smaller clutches in British Columbia are likely due to the smaller average size of the females (Shewchuk 1997).

There was a strong positive correlation between female size and clutch size in a population in Idaho. The clutch size was 6.9+2.10 (3-11), clutch mass was 125.6+66.67 g (70.0-199.5), and relative clutch mass was 0.34+0.119 (0.18-0.47) (Diller and Wallace 1996). Parker and Brown (1980) reported a mean clutch size of 8.4 eggs for *P.c. deserticola* in Utah, and Fitch (1949) found a mean clutch size of 8.9 for western subspecies of *Pituophis*. Relative clutch mass (RCM) in *P.c. deserticola* in a British Columbia study was 46% (RCM = clutch mass/post-laying body mass (of female), and mean relative egg mass was 9.9% (Shewchuk 1997). Comparable numbers for snakes in Idaho were 38.9% RCM and 6.72% relative egg mass (Parker and Brown 1980). The difference could indicate that reproduction involves a greater investment by females in British Columbia (Shewchuk 1997).

Ambient temperature affects incubation and hatching time, with decreasing incubation temperature leading to longer development time. The incubation temperature can affect the subsequent behaviour and survivorship of the offspring. Generally, hatchlings incubated at 26-28°C emerged earlier and moved faster than hatchlings incubated at 30-33°C or 21-23°C (Burger 1991). Individuals incubated in wet conditions tend to be heavier than those from drier conditions (Gutzke and Packard 1987), which may also lead to differences in hatchling size between populations.

The hatchlings in Idaho average 386 mm SVL and 13.4 g (Nussbaum et al. 1983). Hatchlings are 11.9-22.4 g and 253-303 mm SVL at hatching (369.8 mm SVL and 16.8 g on average in B.C. (Shewchuk 1997)). They hatch and emerge in late September or October, and usually overwinter in a talus slope. They probably do not feed before spring, and rely on the residual yolk after hatching (Nussbaum et al. 1983). Female and male hatchlings were not significantly different in size.

There was no significant difference in the number of male and female hatchlings in B.C. (Shewchuk 1997), as was also found by Parker (1974) in Utah. A population of

P.c. sayi in Nebraska showed a skewed sex ratio in both adults captured in the field and in clutches of eggs hatched in the laboratory, with a ratio of about 2 males:1 female (Gutzke et al. 1985). Adult *P.c. deserticola* in Utah also showed a male bias in the sex ratio (Parker and Brown 1980), but a population in B.C. did not (Shewchuk 1997). As females do not disperse as far from the den as males (Parker and Brown 1980), it is possible that females compete more strongly for resources and selection would favour production of more males (Gutzke et al. 1985). However, it is likely that males are easier to catch than females (Gutzke et al. 1985). In British Columbia, males were recaptured more frequently than females and were more often caught in traps, but were not more likely to be killed on roads. Females were most active in the evenings in the summer, whereas males were most active in the evening in the spring (Shewchuk 1997). These behavioural differences between the sexes lead to differences in likelihood of capture, making it difficult to estimate the true sex ratio in a population.

Physiology

The optimum temperature for activity in *P. catenifer* is 30°C (Greenwald 1971). The median cloacal temperature of Gophersnakes in Idaho was 30.1°C, with a skewed distribution toward lower temperatures. Snakes were most frequently captured when the ground temperature was 33°C and the air temperature 22°C (Diller and Wallace 1996). In British Columbia, the mean body temperature over the entire field season was 27.0+3.9°C, with the majority of readings between 27 and 31°C and none over 34°C. There does not appear to be any difference in body temperatures between males and females, although females show a greater range of body temperatures when gravid (Shewchuk 1997).

Gophersnakes exert behavioural control over their body temperatures and do not merely follow environmental temperature fluctuations. The different patterns of temperature variation were associated with the occupation of different microhabitats and with different activities (Shewchuk 1997). Although Parker (1974) concluded that Gophersnakes are passive in their thermoregulation, allowing their body temperatures to drop late in the day, Shewchuk (1997) found that they maintained relatively stable temperatures.

Shed skins are found throughout the summer months in B.C.; however, there appears to be a definite shedding period at the end of July, and hatchlings shed soon after hatching (Shewchuk 1997). Parker and Brown (1980) found that hatchlings shed on average 16 days after hatching, and females shed about 6 days before oviposition. Most of the snakes had already shed before reaching the den prior to hibernation (Parker and Brown 1980). Snakes appeared to require about 10 days to complete the shed cycle (from becoming opaque to actually shedding), and remained in one location during this time (Shewchuk 1997). *Pituophis c. catenifer* in the New Jersey Pine Barrens were shown to sequester metals in the skin, and rid themselves of the metals when they shed, suggesting that snakes could be used for biomonitoring studies (Burger 1992).

Food habits

These snakes feed by actively searching in burrows, under rocks, and in vegetation (Diller and Wallace 1996), and kill their prey by constriction (Stebbins 1985). The diet in Idaho by biomass consisted of 65% juvenile *Sylvilagus nuttallii* (mountain cottontail) and juvenile *Spermophilus townsendii* (Townsend ground squirrel), 16% *Peromyscus maniculatus* (deer mouse), and 19% other small mammals, lizards, and birds (Diller and Johnson 1988; Diller and Wallace 1996). In northern Utah, Gophersnakes fed mainly on mice and voles (Parker and Brown 1980). In Nebraska, on a wildlife refuge, the diet was mostly waterfowl eggs and nestlings (Imler 1945). Individual snakes have been found with neonate mammals or bird eggs in their stomachs, indicating that this species raids nests. In California, Fitch (1949) found *P.c. catenifer* fed on *Spermophilus beechyei* and woodrats, as well as neonate rodents and bird eggs, and this subspecies will also eat antelope squirrels (*Ammospermophilus nelsoni*) (Jennings et al. 1996). There appear to be geographic differences in the feeding habits of *P. catenifer* over its range in western North America (Rodríguez-Robles 1998a), but there does not appear to be any preference for one prey species over another because prey species appear in the diet in roughly the same proportions that they occur in the environment (Diller and Wallace 1996). Observations in British Columbia suggest that Gophersnakes are opportunistic feeders (Shewchuk, pers. obs). It is likely that the decline of wildfires in the grassland habitat of *P.c. ruthveni* has led to the decline of pocket gophers and thus, through changes in the vegetation, Gophersnakes (Rudolph et al. 1998).

In one study in Idaho, immature snakes took only small prey, but for adults there was little correlation between snake and prey sizes and prey items averaged 45% of body mass (Diller and Wallace 1996). The average relative meal size in B.C. was 25%, probably less than in other studies because small prey animals were more common (Shewchuk 1997). First-year snakes had higher consumption rates than older snakes, but there were no significant differences between sexes. Annual consumption rates for first-year snakes was 2.2 x their mass, and for adults was 1.5 x their mass. The feeding period of the snakes is about 100 days each year, from late April to early August. Gophersnakes removed 4% of the juvenile ground squirrels and 23-43% of the juvenile rabbits on a study site every year, although this is probably an underestimate as it was difficult to estimate capture of nestling mammals (Diller and Johnson 1988).

Shewchuk (1997) found that 13% of the snakes caught during his study had food items in their stomachs. Most of these were found in May. The food items consisted of 91% mammals and the rest were juvenile birds. On one occasion, a juvenile Gophersnake ate six neonate garter snakes when temporarily housed with them. None of the snakes contained more than one species of prey, but 27% of them had multiple food items, all of which were neonate rodents or nestling birds (Shewchuk 1997). Gophersnakes have been seen climbing posts and trees to get young bluebirds in nest boxes (D. Low, pers. comm.).

The largest snakes did not always consume the largest prey items, but would sometimes contain large meals consisting of several smaller food items (Shewchuk 1997). Juvenile Gophersnakes apparently do not eat for several weeks after hatching (Smith 1956), which means in Canada they probably do not eat until the spring following hatching.

Growth and survivorship

Typically, growth is rapid over the first three years, then slows. Males mature at one or two years of age, whereas females mature at three to five years. However, it is very probable that the snakes do not actually reproduce until much older. Evidence of reproduction in male Gophersnakes in British Columbia has only been seen in snakes greater than 5 years (M Sarell, pers.comm.). Parker and Brown (1980) determined that about one third of the females in their study site in Utah were mature at age 3, 45% at age four, and the rest at age five, and all males were mature by two years of age. Maturation is at about 700 mm SVL for males and 750 mm SVL for females in Utah, and 720 mm SVL for males and 814 mm SVL for females in Idaho. The smallest reproductive female collected in British Columbia was 695 mm SVL, while the smallest apparently sexually active male was 745 mm SVL (Shewchuk 1997). Males were larger than females in the Utah population, but there was no sexual size dimorphism noted in Idaho Gophersnakes (Nussbaum et al. 1983). There was also no difference between the sexes in size of adults or growth rates of Bullsnakes in Kansas (Platt 1984). Most of the largest adults in British Columbia were males, but the difference in size between sexes was not statistically significant (Shewchuk 1997).

It is not possible to tell the age of a Gophersnake from its size, other than the young of the year (Parker 1974; Platt 1984; Shewchuk 1997), and there tends to be much individual variability in growth rate (Platt 1984). Mean growth rate per year for adult males was 22.6+28.3 SD mm/year, and for females was 42.3+49.3 SD mm/year; these were not significantly different from each other (Shewchuk 1997). Parker (1974) found mean growth rates for snakes of 900-950 mm SVL were 60 mm/yr (males) and 42.5 mm/yr (females); 950-1000 mm SVL snakes grew 38.1 mm/yr (males) and 24.3 mm/yr (females); 1000-1100 mm SVL snakes grew 18 mm (males) and 15 mm/yr (females); 1100-1250 mm SVL snakes grew 11.9 mm/yr (males) and 40 mm/yr (females). First-year males in Kansas grew an average of 55.4 mm/month, while females grew 57.6 mm/month, and males older than 1 year had a mean growth rate of 16.0 mm/month compared to females with 19.7 mm/month (Platt 1984).

Hatching occurs in the south Okanagan in late September/early October, when temperatures can dip below freezing. Hatchlings probably do not den with the adults, and probably suffer high overwinter mortality (Shewchuk 1997). In Utah, 89% of the adults and 29% of the juveniles survived hibernation. Annual survivorship of adults ranged from 66.7% for 2-year-old females to 100% for 5-year-old males; females suffered 15% higher mortality than males in older age groups (Parker and Brown 1980).

About 9% of the snakes collected in British Columbia showed noticeable scars or injuries, and there was no significant difference between the proportion of injured males

and females. Most of the scars were on the ventral surface and appeared to be puncture wounds possibly inflicted by birds or from being tangled in bird netting (Shewchuk 1997; M. Sarell, pers.comm.). In Utah, 2% of the captured snakes were injured (Parker 1974), and twice as many males were injured as females at one den site (Parker and Brown 1980). Although most of these injuries are likely due to attempted predation events, some were probably caused by birds or small mammals (e.g. Engeman and Delutes 1994 for ground squirrels) defending themselves or their nests.

There did not appear to be any competition between *P. catenifer* and the Western Rattlesnake (*Crotalus viridis*) Idaho, even though they shared basking and refuge sites and hibernacula. Gophersnakes were taken by predators about 10 times more often than rattlesnakes (Diller and Wallace 1996). Predators of Gophersnakes include skunks (Shewchuk 1997), raptors, coyotes, badgers and foxes. Racers and birds, such as magpies and crows, probably prey on juveniles (Shewchuk, pers. obs). Weasels and red-tailed hawks are also likely predators (Parker 1974). In the New Jersey Pine Barrens, 21% of nests of *P. melanoleucus* (Pinesnake) were dug up by red foxes, 1% by skunks, and 29% by people. A Scarletsnake (*Cemophora coccinea*) was observed eating an egg in a nest. In the hibernacula, predation from foxes, skunks, and shrews was observed, but only on hatchlings. Other overwinter mortality was the result of fire forcing a snake out of the den, and failure of some snakes to go deep enough to avoid freezing (Burger et al. 1992).

Hibernation

Pituophis c. deserticola in Utah spend 179-250 days in hibernation. They emerge over a period of about 29-48 days in late April to late May (Nussbaum et al. 1983). In B.C. they appear to hibernate from late September/mid-October until late March/mid-April (Shewchuk 1997). In Alberta, *P.c. sayi* also enter hibernation in September and October (Didiuk 1999a). The specific conditions that cause the snakes to return to the dens and begin to hibernate are not known, but shorter days and colder nights are probably cues that the snakes use to determine when to head back to the dens. However, some males returned to the dens in July, indicating that body condition (such as percent body fat) may be an important stimulus for them (Shewchuk 1997).

Behaviour

Summer home ranges of individual Gophersnakes in B.C. showed a large amount of overlap with each other, and for a single individual there was much overlap from year to year. There was no difference in the size of male and female summer home ranges, especially if migrations to nest sites are disregarded (Shewchuk 1997). While Parker (1974) found home ranges in Utah were 1-3 ha, in B.C. they were 13.9 ha for females and 5.3 ha for males; this is probably due to a greater separation of habitats at the B.C. study site (Shewchuk 1997).

Pituophis c. sayi is known to excavate soil as it burrows, moving the soil out of the way using the head and anterior body. The burrowing behaviour is apparently used to pursue pocket gophers or other food, or to create a nesting or retreat site (Carpenter

1982). *Pituophis c. deserticola* is not reported to actively burrow, but will clear excess soil out of rodent burrows before nesting (Shewchuk 1997).

When *Pituophis* are disturbed, they coil up and vibrate the tail tip, which, when done in a substrate such as dry leaves, produces a sound like a rattlesnake's rattle (Gregory and Campbell 1984). They also produce a distinctive hollow hissing noise, produced in part by an epiglottal keel unique to *Pituophis* (Young et al. 1995). These snakes rely on cryptic coloration as the main defense, and only actively defend themselves when the crypsis fails. When this happens, the snake will draw itself into a loose coil and elevate the anterior third of its body. The tail tip is vibrated and the head flattened laterally, and the snake will start to hiss loudly (Sweet 1985; W. Hollet pers. comm.). Juveniles tend to have a more pronounced display than adults (Sweet 1985), possibly because they are exposed to a greater range of predators due to their smaller size. This display has led many people to believe they are being confronted by a rattlesnake, which probably increases the likelihood that the person will kill the snake. Although *Pituophis* is blotched like a rattlesnake, it is a poor mimic of *Crotalus* spp. and the similarities are more likely from selection for the same habitats. For example, the syntopic Nightsnake (*Hypsiglena torquata*) and juvenile racers (*Coluber constrictor*) also have blotched patterns (Sweet 1985; Storm and Leonard 1995). This resemblance to rattlesnakes does not fool everyone, however. An adult ground squirrel (*Spermophilus lateralis*) was observed holding a *P.c. deserticola* at bay near the squirrel's nest. The squirrel attacked the snake if it moved, and even managed to injure it (Engeman and Delutes 1994).

Activity and migration

Pituophis c. deserticola in Idaho were active between early April and late October, with most of the snakes captured in May and June (Diller and Wallace 1996). Gophersnakes in B.C. were also caught in greater numbers in May, probably due to spring dispersal and mating behaviour, and to cooler temperatures allowing for more activity during daylight hours (Shewchuk 1997). There were few observations in late summer and autumn. Males were captured more during May and early June than were females (Diller and Wallace 1996; Shewchuk 1997). Males probably emerge earlier to be sexually ready to mate when the females emerge. In spring, surface activity peaked at mid-day, whereas in summer, activity peaked in mid-morning and evening. Snakes were occasionally found after dark (Diller and Wallace 1996; Shewchuk 1997); however, night searches tend to be limited. Reduced captures in the summer were partly due to snakes having reached their summer refuges and become more difficult to observe. High temperatures in the summer and prey unavailability cause the snakes to retreat underground (Diller and Wallace 1996); in about 80% of summer observations using telemetry the snakes were found underground (Shewchuk 1997). Females were found to be more active in August, possibly to restore the resources used in producing eggs (Shewchuk 1997). Daily activity patterns in the summer seem to have been dictated by the snakes' foraging strategy and its thermal constraints (Diller and Wallace 1996).

In the south Okanagan, Gophersnakes spent most of the active season in sand and riparian habitats, using specific retreat sites from which to base foraging

movements (Shewchuk 1997). These retreat sites were usually rodent burrows in the sand habitat near the top of south-facing hills, and probably offered physical and thermal protection. Other retreat sites consisted of a large rock outcrop with deep fissures and the concrete foundation of a small shed containing electrical equipment. Each snake apparently had its "favourite" location, and any one particular retreat might be used by more than one snake. Like den sites, some retreats were used year after year by the same individuals (Shewchuk 1997).

The annual movement patterns in the south Okanangan can be generalized as follows: in the spring, a long migratory movement from the den site occurs, ending in the active season habitat. This is usually the longest movement made by the snake, and occurs over a short period of time (typically a few days). Next, there are a series of short movements in a small area, usually with a retreat site as a base from which these movements occur. Near the end of the summer, the snake returns to the den site, again usually over a short period of time (Parker 1974; Shewchuk 1997). Females also make long movements associated with egg-laying, and may change their active areas after nesting (Shewchuk 1997).

The average migration distance was 933.9±185.1 m for Gophersnakes in southern B.C. (Shewchuk 1997), compared to about 510 m in Utah (Parker 1974). The distance travelled from the dens is most likely dependent on the distribution of habitat types in the surrounding area. Males began returning to den sites at the end of July, but females remained active until September (Shewchuk 1997). Females did not appear to move more overall than males (including spring and fall migrations and nesting movements), and were found to be moving for the same proportion of observations as males (Shewchuk 1997). Snakes remain inactive for up to two weeks (Parker 1974; Shewchuk 1997), apparently associated with shedding.

POPULATION SIZES AND TRENDS

Population size

No comprehensive inventory has been made of *P.c. deserticola* populations, and there have been fewer than 100 occurrences reported in British Columbia (British Columbia, Conservation Data Centre 1998). The populations in Trail, Grand Forks and Midway are likely small and are connected to a larger population in the Okanagan in Similkameen Valleys (Hobbs 2001). The Thompson-Fraser Gophersnakes have become isolated from these other populations since the warm period about 8,000 years ago (Hobbs 2001). Shewchuk (1997) captured 161 Gophersnakes over 3 years at one location and only 18.5% of snakes sampled were recaptured. In southwestern Idaho, *P.c. deserticola* occurred it low to moderate densities (0.1-1.9/ha) (Diller and Johnson 1988). *Pituophis c. deserticola* in one study in Arizona did not show any variation in population size between 1961 and 1989 even though the habitat changed (Mendelson and Jennings 1992).

Pituophis c. sayi is thought to be common throughout certain regions of New Mexico (Best and James 1983), and occurs statewide in Missouri but is not common (Anderson 1965). Overall, it appears to be widespread, but not common except in localized areas. In anecdotal reports, up to "1000" snakes have been recorded at den sites in Alberta, but more often 100 or fewer are found (Alberta Environmental Protection 1998) and it is not clear how many of these are correctly identified as Bullsnakes. A. Didiuk (pers.comm.) feels the numbers are exaggerations. At the Suffield National Wildlife Area, Didiuk (1999a) found that Bullsnakes represented about 10% of 600 snakes found in 8 dens.

Population distribution and persistence

The habitat used by *P.c. deserticola* in B.C. has been greatly reduced, therefore the number of populations has likely declined to a corresponding degree. Given the current rate of urban development and expansion in the Okanagan, and the extensive conversion of ranch land to houses, orchards, and vineyards, the rate of decline has probably increased in the last decade. Haying has been cited as the largest source of mortality in the Cariboo (Hobbs and Sarell 2002).

Bullsnakes are historically widely distributed, but generally uncommon in Alberta. There is no information to confirm any decline or disappearance of the Bullsnake from any part of its former range; however, there are no recent records at many of the historic locations (Cottonwood Consultants 1986), and the only location where they are known to have remained stable is along the South Saskatchewan River near Medicine Hat. Of 20 den sites recorded across Alberta in 1986, most had only "tens" of Bullsnakes, whereas historical accounts suggest there were "hundreds" at some dens in the past. Almost half of these dens do not exist now or have not been visited for many years (Cottonwood Consultants 1987). Currently, distribution and abundance of the Bullsnake is being assessed in Alberta (S. Brechtel, pers. comm. 2002).

Trends

Pituophis c. catenifer is most likely extirpated from British Columbia, as there were only two records ever made and the habitat that could have been occupied has largely disappeared from the southwest mainland and Gulf Islands (BC-CDC 1998). Populations of *P.c. sayi* formerly considered to be large are apparently declining, even in protected areas such as Dinosaur Provincial Park (Cottonwood Consultant 1987). It is possible that many populations of *P.c. deserticola* will eventually be extirpated. However, the data are anecdotal and, although there is no doubt that the species has declined or disappeared where there is extensive cultivation, trends for the Bullsnake in grassland areas on the prairies are not established (A. Didiuk, pers. comm.).

LIMITING FACTORS AND THREATS

The main threat to *P. catenifer* is loss of habitat. The lower Fraser Valley and Gulf Islands, where *P.c. catenifer* was found, have been converted to farmland and urban habitat, and Scotch broom has taken over much of the grassland habitat on the islands. The habitat of *P.c. deserticola* is also declining in area and quality, because of vineyard and orchard expansion, and urbanization. The increased number of paved roads and traffic thereon have probably resulted in greater rates of road mortality particularly as the Gophersnake is a slow moving species and tends to seek warmth on surfaces of rocks and paved roads (BC-CDC 1998, Cannings et al. 1999). Haying is probably the largest source of mortality in the Cariboo region (Thompson/Fraser) of British Columbia. Threats to the Bullsnake in Alberta include loss of prairie grasslands and hibernacula (Cottonwood Consultants 1986). Road and pipeline construction across valley slopes have destroyed dens (Cottonwood Consultants 1987). In Saskatchewan, much of the grassland is used for crop production or grazing and snakes are vulnerable to trampling as well as loss of habitat (BC-CDC 1998). Many Gophersnakes and Bullsnakes are probably deliberately killed by humans because of their superficial resemblance to rattlesnakes and a general intolerance many people have for all snakes, particularly large ones.

Gophersnakes in the northern part of their range in B.C. are also suffering from reduction of their prey base through forest encroachment into parkland and grassland habitats (from lack of regular fires). Grazing around mesic to subhygric sites which allows large sagebrush plants to occupy those sites has reduced vole habitat and, therefore, the number of vole prey available (D. Low, pers. comm.).

Pituophis catenifer in California use road surfaces to thermoregulate by pressing themselves against the surface (Sullivan 1981), making this species prone to being killed on roads. Not only are they hit by vehicles, but their behaviour makes them more conspicuous and vulnerable to people. Gophersnakes often approach human habitation in the search for food items, which also exposes them to greater human persecution.

This species is at the northern limit of its range in Canada, and has a limited distribution in this country. Lethal winter temperatures could limit the distribution of Gophersnakes in Canada, and would especially affect hatchlings. The active season is apparently not long enough for females to reproduce every year and may not always be long and warm enough for eggs to complete incubation. Females seem to mature at a smaller size than populations farther south, and at a later age (Shewchuk 1997). If Gophersnakes and Bullsnakes take longer to mature in Canada than in more southerly populations, then the Canadian populations would be slower to recover from declines than ones further south. Gophersnakes tend to have high adult survivorship and lower fecundity than other snakes (Parker and Plummer 1987), which is apparently an advantage in an unpredictable environment as the conditions of any one year will not greatly affect total lifetime reproductive output. However, this again could mean that they are slower to recover from declines, and are more susceptible to chronic increases

in mortality rates of adults; for example from increased mortality on roads, from encounters with people and from destruction of hibernacula.

SPECIAL SIGNIFICANCE OF THE SPECIES

The Gophersnake is economically important because it preys on small mammals, some of which are major crop pests (Gregory and Campbell 1984). Froom (1972) claims that an American writer estimates that the rodents preyed upon by the Bullsnake could be responsible for about four hundred million dollars' damage annually to the US national grain crop. Regardless, these snakes can remove a large proportion of the small mammals in an area (Diller and Johnson 1988).

EXISTING PROTECTION OR OTHER STATUS

In British Columbia, *P.c. catenifer* is on the red list (endangered), and is ranked SX (apparently extirpated or extinct without the expectation that it will be rediscovered) (Table 2.). *Pituophis c. deserticola* is on the provincial blue list (vulnerable), and is ranked S3 (rare or uncommon). *Pituophis c. sayi* is ranked S3 and is on the yellow B list (naturally rare or associated with declining habitats, not currently at risk) in Alberta and S4 (frequent to common with restricted distribution, but of long-term concern with perceived future threats) in Saskatchewan. Globally, *P.c. catenifer*, *P.c. deserticola*, and *P.c. sayi* are all ranked G5T5 (subspecies is secure, common, typically widespread and abundant) (BC-CDC 1998).

Pituophis c. deserticola is considered "Identified Wildlife" under the B.C. Forest Practices Code, requiring Wildlife Habitat Areas (WHA) around known hibernacula, or overwintering sites (M. Sarell, pers. comm.). All snakes are protected under the British Columbia Wildlife Act, and populations in any wildlife areas are protected from disturbance and collection by the Canada Wildlife Act of 1982. Nevertheless, many people still kill snakes although this may be becoming less common. There seems to be some recent interest in protecting hibernacula from road construction.

It appears that there are populations of Gophersnakes in many of the protected areas in the Okanagan Valley, but most of these parks and reserves are too small to provide all of the different habitat types required by the snakes, especially in the south Okanagan (Shewchuk, pers. obs). Approximately 20% of the historic locations in Alberta are in provincial parks. There are "good" populations in Dinosaur and Writing-on-Stone Provincial Parks (Cottonwood Consultants 1986), and on CFB Suffield (Didiuk, pers. comm.). Very little of the species' range in Saskatchewan is protected, but much of the species' range is "somewhat protected" in that it is on community pastures and protected from cultivation under the Wildlife Habitat Protection Act (A. Didiuk, pers. comm.). How well the snakes could thrive in this habitat is not clear.

Table 2. Provincial and state status of *Pituophis catenifer* subspecies in Canada (The Nature Conservancy/Natural Heritage Project/Conservation Data Centre global rank G5T5).

	Provincial	United States
Deserticola	B.C. - blue list (vulnerable, at risk), S3, Forest Practices Code Identified Wildlife	Arizona - S5 California - species of special concern Colorado – none Idaho – none Nevada – none Oregon – none Utah – none Washington - S5
Catenifer	B.C. - red list (extirpated, endangered, or threatened), SX	California - species of special concern Oregon - none
Sayi	Alberta - yellow B list (sensitive species not currently believed to be at risk, naturally rare), S3 Saskatchewan - S4, not a tracking species	TNC National rank - N5 Colorado – none Indiana – none Iowa – none Kansas –none Minnesota - special concern Missouri – none Montana – none Nebraska – none New Mexico – none North Dakota – none Oklahoma – none South Dakota – none Texas – none Wisconsin - S3S4, special concern with no protection Wyoming - none

S = provincial or state rank
5 = common to very common
4 = frequent to common, apparently secure but may be long-term concern
3 = rare or uncommon, may be susceptible
X = apparently extirpated or extinct without the expectation that it will be rediscovered
(information obtained from various Conservation Data Centres, Natural Heritage Programs, Departments of Natural Resources, and Fish and Wildlife Departments)

SUMMARY OF STATUS REPORT

The most important factor in assessing status of *Pituophis catenifer* spp. is loss of their habitat, through alteration, destruction and fragmentation. The Okanagan Valley, where the majority of *P.m. deserticola* was found, has less than 9% of its area remaining in an undisturbed state (Redpath 1990). In the southern portions of the valley, 60% of grassland and shrubland habitat has been lost to vineyards, orchards and urban development (MELP 1998). Suitable nesting and den sites may already be limited, and the disturbance of important habitat features could disrupt the population. Gophersnakes require different habitats for different purposes throughout the year. Therefore, all required

habitat types need to be preserved. The construction of roads through habitats and across migration routes has led to an increase in the number of snakes killed on the roads, and urbanization has increased the amount of contact with humans.

In recent surveys of hibernation sites (Bertram et al. 2001, Hobbs 2001, Hobbs and Sarell 2002), the researchers concluded that most ideal Gophersnake habitat is within a kilometre of roads or development, that snakes appear to decrease in abundance closer to roads, and that snakes have highly specific den site requirements and show high fidelity to these sites and therefore are affected by talus extraction. In addition, the snakes are attracted to roads and have limited sites in which to deposit eggs.

TECHNICAL SUMMARY

Pituophis catenifer catenifer
Pacific Gophersnake — Couleuvre a nez mince (Pacifique)
Formerly in southern British Columbia and coastal islands

Extent and Area information	
• *extent of occurrence (EO)(km²)*	0km²
• *specify trend (decline, stable, increasing, unknown)*	Stable
• *are there extreme fluctuations in EO (> 1 order of magnitude)?*	No
• *area of occupancy (AO) (km²)*	0km²
• *specify trend (decline, stable, increasing, unknown)*	Stable
• *are there extreme fluctuations in AO (> 1 order magnitude)?*	No
• *number of extant locations*	0
• *specify trend in # locations (decline, stable, increasing, unknown)*	Stable
• *are there extreme fluctuations in # locations (>1 order of magnitude)?*	No
• *habitat trend: specify declining, stable, increasing or unknown trend in area, extent or quality of habitat*	Decline in extent and quality of habitat
Population information	
• *generation time (average age of parents in the population) (indicate years, months, days, etc.)*	> 5 years
• *number of mature individuals (capable of reproduction) in the Canadian population (or, specify a range of plausible values)*	0
• *total population trend: specify declining, stable, increasing or unknown trend in number of mature individuals*	Extinct
• *if decline, % decline over the last/next 10 years or 3 generations, whichever is greater (or specify if for shorter time period)*	--
• *are there extreme fluctuations in number of mature individuals (> 1 order of magnitude)?*	--
• *is the total population severely fragmented (most individuals found within small and relatively isolated (geographically or otherwise) populations between which there is little exchange, i.e., ≤ 1 successful migrant / year)?*	No
• *list each population and the number of mature individuals in each*	0
• *specify trend in number of populations (decline, stable, increasing, unknown)*	Stable
• *are there extreme fluctuations in number of populations (>1 order of magnitude)?*	No
Threats (actual or imminent threats to populations or habitats)	
- loss of habitat to agriculture and urbanization - human persecution - probably originally a small, relict population	
Rescue Effect (immigration from an outside source)	
• *does species exist elsewhere (in Canada or outside)?*	Yes
• *status of the outside population(s)?*	Not at Risk
• *is immigration known or possible?*	Not known, possible
• *would immigrants be adapted to survive here?*	Yes
• *is there sufficient habitat for immigrants here?*	No
Quantitative Analysis	--

Pituophis catenifer deserticola
Great Basin Gophersnake — Couleuvre a nez mince (Great Basin)
Thomson, Okanagan, Nicola, Similkameen, Fraser Valleys, British Columbia

Extent and Area information	
• *extent of occurrence (EO)(km²)*	25,000 km²
• *specify trend (decline, stable, increasing, unknown)*	Declining
• *are there extreme fluctuations in EO (> 1 order of magnitude)?*	No
• *area of occupancy (AO) (km²)*	<2,000 km²
• *specify trend (decline, stable, increasing, unknown)*	Declining
• *are there extreme fluctuations in AO (> 1 order magnitude)?*	No
• *number of extant locations*	6
• *specify trend in # locations (decline, stable, increasing, unknown)*	Unknown, possibly have declined
• *are there extreme fluctuations in # locations (>1 order of magnitude)?*	No
• *habitat trend: specify declining, stable, increasing or unknown trend in area, extent or quality of habitat*	Decline in extent and quality of habitat
Population information	
• *generation time (average age of parents in the population) (indicate years, months, days, etc.)*	>7 years
• *number of mature individuals (capable of reproduction) in the Canadian population (or, specify a range of plausible values)*	Unknown (likely fewer than 5,000)
• *total population trend: specify declining, stable, increasing or unknown trend in number of mature individuals*	Decline
• *if decline, % decline over the last/next 10 years or 3 generations, whichever is greater (or specify if for shorter time period)*	Unknown
• *are there extreme fluctuations in number of mature individual (> 1 order of magnitude)?*	No
• *is the total population severely fragmented (most individuals found within small and relatively isolated (geographically or otherwise) populations between which there is little exchange, i.e., ≤ 1 successful migrant / year)?*	Increasingly fragmented
• *list each population and the number of mature individuals in each*	Number of adults unknown Okanagan/Similkameen Kettle (Grand Forks/Midway) Columbia (Trail) – probably extirpated Thompson/Nicola/Fraser
• *specify trend in number of populations (decline, stable, increasing, unknown)*	Declining?
• *are there extreme fluctuations in number of populations (>1 order of magnitude)?*	No
Threats (actual or imminent threats to populations or habitats)	
- loss of habitat to agriculture (vineyards, orchards, range land) and urbanization - increased number of roads and traffic leads to increased road mortality - direct human persecution - destruction of hibernacula	

Rescue Effect (immigration from an outside source)	
• *does species exist elsewhere (in Canada or outside)?*	Yes
• *status of the outside population(s)?*	Not currently at significant risk
• *is immigration known or possible?*	Not known, possible
• *would immigrants be adapted to survive here?*	Yes
• *is there sufficient habitat for immigrants here?*	Probably not
Quantitative Analysis	–

Pituophis catenifer sayi
Bullsnake — Couleuvre a nez mince
Southern Alberta and Saskatchewan

Extent and Area information	
• *extent of occurrence (EO)(km²)*	~ 500,000km^2
• *specify trend (decline, stable, increasing, unknown)*	Stable
• *are there extreme fluctuations in EO (> 1 order of magnitude)?*	No
• *area of occupancy (AO) (km²)*	< 100,000 km^2
• *specify trend (decline, stable, increasing, unknown)*	Decline
• *are there extreme fluctuations in AO (> 1 order magnitude)?*	No
• *number of extant locations*	Unknown
• *specify trend in # locations (decline, stable, increasing, unknown)*	Decline ?
• *are there extreme fluctuations in # locations (>1 order of magnitude)?*	No
• *habitat trend: specify declining, stable, increasing or unknown trend in area, extent or quality of habitat*	Decline in extent and quality of habitat
Population information	
• *generation time (average age of parents in the population) (indicate years, months, days, etc.)*	> 5 years
• *number of mature individuals (capable of reproduction) in the Canadian population (or, specify a range of plausible values)*	Unknown
• *total population trend: specify declining, stable, increasing or unknown trend in number of mature individuals*	Decline
• *if decline, % decline over the last/next 10 years or 3 generations, whichever is greater (or specify if for shorter time period)*	--
• *are there extreme fluctuations in number of mature individuals (> 1 order of magnitude)?*	--
• *is the total population severely fragmented (most individuals found within small and relatively isolated (geographically or otherwise) populations between which there is little exchange, i.e., ≤ 1 successful migrant / year)?*	No
• *list each population and the number of mature individuals in each*	Unknown
• *specify trend in number of populations (decline, stable, increasing, unknown)*	Decline likely
• *are there extreme fluctuations in number of populations (>1 order of magnitude)?*	No
Threats (actual or imminent threats to populations or habitats)	
- loss of grassland habitat for cultivation and irrigation - extensive cattle grazing in current range, reduced prey, trampling by cattle - increased number of roads and traffic - human persecution at hibernacula	
Rescue Effect (immigration from an outside source)	
• *does species exist elsewhere (in Canada or outside)?*	Yes
• *status of the outside population(s)?*	Not at Risk
• *is immigration known or possible?*	Not known, possible
• *would immigrants be adapted to survive here?*	Yes
• *is there sufficient habitat for immigrants here?*	Unknown
Quantitative Analysis	--

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